CLAIMS

1. A device for making electric energy storage assemblies (En), the device comprising multiple feed means (100, 200, 300) for feeding sheet structures, means (400, 410) for laminating the sheet structures received from the various feed means, winder means (610) for winding the resulting laminate, and control means for controlling continuously and in controlled synchronism the feed means, the laminator means, and the winder means.

2. A device according to claim 1, characterized by the fact that it includes laminator means (C, 400, 410) formed by a pair of presser rollers (400, 410).

3. A device according to either preceding claim, characterized by the fact that it comprises a mandrel (610) of generally timezone-shaped section.

4. A device according to any preceding claim, characterized by the fact that the mandrel (610) is of length greater than the width of the laminates for winding.

5. A device according to any preceding claim, characterized by the fact that it includes a mandrel (610) presenting a section that is not circularly symmetrical, and that the device includes means for rotating the mandrel (610) at a controlled non-constant angular speed so as to obtain a constant linear speed for feeding said sheets.

6. A device according to any preceding claim, characterized by the fact that the angular speed of rotation of the winder mandrel (610) presents two peaks per revolution.

7. A device according to any preceding claim, characterized by the fact that the speed of rotation of the winder mandrel (610) is determined by the relationship:

$$\omega = V/(2.\pi.r)$$

in which:

V represents the desired constant linear speed for the laminate; and

r represents a winding radius itself calculated on the basis of the following relationship:

$$r = r_0 + (F.n.e)$$

in which:

$r_0$ represents the radius of the mandrel (610) when bare;

F represents a correction factor;

n represents the number of the current turn; and

e represents the thickness of the laminate wound on the mandrel (610).

8. A device according to any preceding claim, characterized by the fact that a presser roller (620) is associated with the winder mandrel (610).

9. A device according to the preceding claim, characterized by the fact that the presser roller (620) is carried by rotary equipment (624) mounted to rotate about an axis (625) that is eccentric relative to the axis of the presser roller (620).

10. A device according to the preceding claim, characterized by the fact that the rotary equipment (624) that carries the presser roller (620) is rotated at an angular speed that is twice that of the mandrel (610).

11. A device according to claim 10, characterized by the fact that the rotary equipment (624) is mechanically

driven by rotation of the mandrel (610) with a velocity ratio of 2.

12. A device according to any preceding claim, characterized by the fact that the mandrel (610) is made up of two adjacent jaws (612, 614).

13. A device according to claim 12, characterized by the fact that the two jaws (612, 614) are symmetrical and their plane of symmetry contains the axis of rotation (611) of the mandrel (610).

14. A device according to claim 12 or claim 13, characterized by the fact that it includes drive means suitable for moving the two jaws (612, 614) making up the mandrel (610) into an open relative position.

15. A device according to any one of claims 12 to 14, characterized by the fact that it includes drive means suitable for moving the two jaws (612, 614) making up the mandrel (610) relative to each other parallel to their interface plane.

16. A device according to any preceding claim, characterized by the fact that it includes a press (710) suitable for finishing off flattening the windings formed on the mandrel (610) after said windings have been extracted to a position separate from the mandrel.

17. A device according to any preceding claim, characterized by the fact that it includes at least three sheet feed means (104, 204, 304) and laminator means (C, 400, 410) for laminating sheets coming from the three feed means.

18. A device according to any preceding claim, characterized by the fact that it includes three sheet

feed means (104, 204, 304) serving respectively to feed: an assembly (90) comprising a cathode (60) and an electrolyte (50); an assembly (40) comprising an anode sheet (40); and an assembly (92) comprising a collector (10), a cathode (20), and an electrolyte (30).

19. A device according to any preceding claim, characterized by the fact that it includes heater means (130, 330) disposed upstream from said laminator means (C, 400, 410).

20. A device according to the preceding claim, characterized by the fact that the heater means comprise ovens (130, 330).

21. A device according to claim 19, characterized by the fact that the heater means comprise heater rollers.

22. A device according to any one of claims 19 to 21, characterized by the fact that the heater means comprise means suitable for sequentially cooling treated sheets.

23. A device according to any preceding claim, characterized by the fact that it includes means (104, 304) suitable for feeding at least one assembly (90, 92) comprising at least one sheet covered by at least one protective film.

24. A device according to any preceding claim, characterized by the fact that it includes film-remover means (122, 322, 220, 225, 541, 543) suitable for removing at least one film placed on an assembly.

25. A device according to the preceding claim, characterized by the fact that the film-remover means comprise means suitable for abruptly diverting a

protective film through at least 60° relative to the assembly carrying it.

26. A device according to claim 24 or claim 25, characterized by the fact that the film-remover means comprise a dull edge (232) close to the plane of displacement of a film to be removed, and upstream from the point of remover, with the convex side of the edge facing downstream in the displacement direction, suitable for micro-stretching a protective film covering said sheet when the film is deflected by being pulled over the edge.

27. A device according to any one of claims 24 to 26, characterized by the fact that it includes means suitable for adjusting the traction force exerted on the film.

28. A device according to claim 24, characterized by the fact that the film-remover means comprise means for applying a jet of solvent.

29. A device according to claim 24, characterized by the fact that the film-remover means comprise means for applying a jet of air to the zone where the film and the assembly from which it is being removed diverge.

30. A device according to any preceding claim, characterized by the fact that it includes applicator means (262, 264) suitable for applying at least one protective film on at least one outside face of an anode sheet (40).

31. A device according to the preceding claim, characterized by the fact that the anode sheet (40) is a lithium sheet.

32. A device according to any preceding claim, characterized by the fact that it includes means (240) suitable for applying a film (84) to the periphery of an anode reel (40) over a winding arc of not less than 90°.

33. A device according to any preceding claim, characterized by the fact that it includes means (220, 225) suitable for removing at least one film (84, 85) upstream from a laminator station (400, 410).

34. A device according to any preceding claim, characterized by the fact that it includes means (541, 543) suitable for removing at least one film (80, 83) upstream from a winder station (610).

35. A device according to any preceding claim, characterized by the fact that it includes means (240, 250) suitable for placing protective films (84, 85) on at least some of the sheets involved.

36. A device according to any preceding claim, characterized by the fact that it uses films (80, 81, 82, 83, 84, 85) covering at least some of the sheets involved and forming a drive function thereon.

37. A device according to any preceding claim, characterized by the fact that it uses films (80, 81, 82, 83, 84, 85) covering at least some of the sheets involved and performing an anti-stick protection function for the sheets relative to rollers on their paths.

38. A device according to any preceding claim, characterized by the fact that it includes means for adjusting the relative positioning of the longitudinal edges of the sheets involved.

39. A device according to the preceding claim, characterized by the fact that the adjustment means comprise position sensors (140, 280, 340) and displacement means for moving the feed unwinders.

40. A device according to the preceding claim, characterized by the fact that the displacement means are adapted to pivot support plates carrying feed unwinders.

41. A device according to claim 39 or claim 40, characterized by the fact that the displacement means are adapted to pivot support plates carrying feed unwinders about axes (102, 202, 302) that are parallel to the segments of sheet conveyed upstream from the laminator means (400, 410).

42. A device according to any one of claims 39 to 41, characterized by the fact that the displacement means are adapted to pivot the support plates supporting feed unwinders about axes (102, 202, 302) intersecting the axes of rotation of the feed unwinders (104, 204, 304) and contained in a plane halfway across the width of the feed reel.

43. A device according to any preceding claim, characterized by the fact that it includes sectioner means (272, 274, 552) for sectioning the sheets involved.

44. A device according to the preceding claim, characterized by the fact that it includes sectioner means (272, 274) for sectioning an anode sheet (40).

45. A device according to the preceding claim, characterized by the fact that it includes sectioner means (272, 274) for sectioning an anode sheet (40) between two films (84, 85) without breaking the films.

46. A device according to any one of claims 43 to 45, characterized by the fact that it includes sectioner means (272, 274) for sectioning an anode sheet (40), the sectioner means being constituted by a hammer (272) and an anvil (274).

47. A device according to the preceding claim, characterized by the fact that at least one of the hammer (272) and the anvil (274) includes at least one striker edge.

48. A device according to any preceding claim, characterized by the fact that it includes sectioner means (272, 274) for sectioning a sheet and drive means for driving the segment situated downstream from the break in order to produce a gap in the sheet.

49. A device according to the preceding claim, characterized by the fact that the sectioned sheet is the anode sheet (40).

50. A device according to any preceding claim, characterized by the fact that it includes sectioner means (552) for completely sectioning a laminate.

51. A device according to any preceding claim, characterized by the fact that it includes sectioner means (552) formed by a blade having a sharp edge with two slopes forming a convex ridge.

52. A device according to any preceding claim, characterized by the fact that it includes motor-driven unwinders (104, 204, 304) and winders (124, 324, 524, 548).

53. A device according to the preceding claim, characterized by the fact that the motor-driven unwinders

(104, 204, 304) are adapted to be controlled sequentially in brake mode.

54. A device according to claim 52 or claim 53, characterized by the fact that the winders (124, 229, 324, 542, 546) are motor-driven and controlled in torque.

55. A device according to any one of claims 52 to 54, characterized by the fact that the unwinders (104, 204, 304) and the winders (124, 324, 542, 546) are controlled by signals that take account of the diameter of the windings.

56. A device according to any preceding claim, characterized by the fact that it include means for measuring the delivered length of laminate.

57. A device according to any preceding claim, characterized by the fact that it includes cutter means for making localized interrupted cuts in a current collector sheet (10).

58. A device according to the preceding claim, characterized by the fact that the cutter means for localized cutting of a current collector sheet comprise an oscillating blade (524) placed facing a first face of the collector, associated with two rollers (526, 528) placed facing the other face thereof.

59. A device according to claim 57 or claim 58, characterized by the fact that displacement of the localized cutter means (524) is controlled by the displacement of the mandrel (610).

60. A device according to any preceding claim, characterized by the fact that it includes heating laminator rollers (400, 410).

61. A device according to any preceding claim, characterized by the fact that it includes laminator rollers (400, 410) having a diameter of at least about 20 mm.

62. A device according to any preceding claim, characterized by the fact that it comprises two compartments separated by a partition (900): a first compartment housing all of the means for moving the sheets and laminates involved, and a second compartment housing all of the control means.

63. A device according to the preceding claim, characterized by the fact that the compartment housing the means for ensuring displacement of the sheets is placed under a controlled atmosphere.

64. A device according to any preceding claim, characterized by the fact that it includes means suitable on command for retracting the sheet-treatment means in order to facilitate putting the sheets into place.

65. A device for making electric energy storage assemblies according to any preceding claim, including a mandrel (610) adapted to wind superposed sheets in the form of a multi-sheet assembly, the device being characterized by the fact that it includes means (670, 680, 800) suitable on command for modifying the right section of the mandrel (610).

66. A device for making electric energy storage assemblies according to any preceding claim, including drive means for driving a laminated sheet and means (610) for winding the laminated sheet, the device being characterized in that the drive means comprise at least one pair of drive means respectively constituting a

master pair and a slave pair (532 & 534 and 400 & 410; 400 & 410 and 262 & 264), the master drive means (532 & 534; 400 & 410) being placed downstream from the slave drive means (400 & 410; 262 & 264) on the travel path of the laminated sheet, and control means for servo-controlling the slave drive means (400 & 410; 262 & 264) on the master drive means (532 & 534; 400 & 410).

67. A device for making energy storage assemblies according to any preceding claim, the device comprising drive means (532, 534, 610) for driving a laminated sheet, winder means (610) for winding the laminated sheet, and cutter means (550) for sectioning the laminated sheet at the end of winding, the device being characterized in that it further comprises heater means (562) for heating the laminated sheet and presser means (580) for pressing the end-of-winding end of the sheet against the surface of the wound assembly so that the winding end adheres to said surface.

68. A device for making electric energy storage assemblies according to any preceding claim, the device comprising drive means for driving a laminated sheet and winder means (610) for winding the laminated sheet (10, 20, 30, 40, 50, 60), the device being characterized in that it further comprises tensioner means (532, 534, 570, 610) for tensioning the laminated sheet over a segment, and moving cutter means (550) suitable for being actuated sequentially to cut the laminated sheet (10, 20, 30, 40, 50, 60) in air through the tensioned segment.

69. A device for making electric energy storage assemblies according to any preceding claim, the device being characterized in that it includes a segment (332) of duct (331) in which the sheet (XIV) extends, and means for causing a flow of hot air and a flow of cold air to circulate in alternation in said segment (332).

70. A device for making a laminated sheet structure according to any preceding claim, the device comprising a plurality of feed means (100, 200, 300) for feeding single-layer or multilayer sheets, drive means for driving travel of the sheets, and means (400, 410) for superposing the sheets coming from the various feed means in order to form a laminate, the device being characterized in that it includes a movable support (190; 290; 390) on which at least one of the feed means (100; 200; 300) for at least one of the sheets is mounted, the movable support (190; 290; 390) being suitable for oscillating about an axis (101; 201; 301) for modifying the lateral positioning of said sheet relative to the other sheets of the laminate.

71. A device for making energy storage assemblies according to any preceding claim, the device comprising feed means (100, 200, 300) for feeding single-layer or multilayer sheets (90, 40, 92), drive means (510) for causing said sheet to travel, means (C) for uniting the sheets in a laminate (96), and a mandrel (610) adapted to wind the sheets in the form of a multilayer winding (10, 20, 30, 40, 50, 60), the device being characterized in that it includes first cutter means (270) for sectioning one or more layers (40) making up the laminate (96) transversely to the laminate travel direction, and second cutter means (550) for sectioning the other layers (10, 20, 30, 50, 60) transversely to the laminate travel direction so that the layer(s) (40) sectioned by the first means (270) is/are set back relative to the other layers (10, 20, 30, 50, 60) at an end of the laminate winding (96).

72. A device according to any one of claims 1 to 71, characterized by the fact that at least three means constituted by the feed means, the laminator means, and

the winder means are associated with respective drive means.

73. A method of making electric energy storage assemblies, the method comprising the steps of feeding multiple sheet structures (90, 40, 92) from distinct feed means (104, 204, 304), laminating (400, 410) the film structures (90, 40, 92) received from the various feed means (104, 204, 304), winding (610) the resulting laminate, and continuously and with controlled synchronism controlling the feed means (104, 204, 304), the laminator means (400, 410), and the winder means (610).

74. A method according to the preceding claim, characterized by the fact that the laminating and winding steps are performed continuously.

75. A device according to claim 73 or claim 74, characterized by the fact that at least one of the feed means is itself formed by means for in situ lamination of at least two initially separate sheets.

76. A device according to any one of claims 73 to 75 for fabricating an energy storage cell, constituted by a flat winding with minimized internal stresses formed of a superposed assembly of sheets comprising at least one current collector (10), a cathode (20) based on filled polymers, a solid electrolyte (30) based on filled polymers, a metal anode (40), preferably based on lithium, these various items being made in the form of thin sheets, the method comprising the steps of laminating said sheets together and then winding and preforming them on an almost flat mandrel (610) having a section that is timezone-shaped, and finally pressing and flattening the winding on a low-thrust press.

77. An energy storage cell obtained by implementing the method in accordance with claim 76, constituted by a flat winding with minimized internal stresses, the cell being characterized in that it is formed by a superposed assembly of sheets comprising at least a current collector (10), a cathode (20) based on filled polymers, a solid electrolyte (30) based on filled polymers, a metal anode (40), preferably based on lithium, these various items being made in the form of thin sheets that are laminated together and then wound and preformed on an almost flat mandrel (610) having a timezone-shaped section, and finally pressed and flattened on a low-thrust press.